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SURFACE STRENGTHENING METHOD FOR TURBINE BLADE
[Tabin Tsubasa No Hyomen Kyoka Hoho]

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/1[1]

Specification

1. <u>Title of the invention</u>

Surface Strengthening Method for Turbine Blade

2. <u>Claims</u>

1. A surface strengthening method for a turbine blade, characterized by the fact that high-energy beams such as laser beams are irradiated to part of the surface of a turbine blade while supplying a hardening material; the above-mentioned hardening material is melted and fused with a blade matrix on the blade surface, so that a surface-hardened layer is formed.

2. The surface strengthening method for a turbine blade of Claim 1, characterized by the fact that the hardening material is composed of a Ni-Cr-Fe alloy containing 15-60 wt% high-hardness particles.

3. The surface strengthening method for a turbine blade of Claim 2, characterized by the fact that the high-hardness particles are composed of one kind or two kinds of metal carbides, metal nitrides, metal oxides, and intermetallic compounds.

[1] Numbers in the margin indicate pagination in the foreign text.

3. Detailed explanation of the invention

(Industrial application field)

The present invention pertains to a surface strengthening method for a turbine blade that forms a surface hardening layer on the surface of a blade such as low-pressure turbine blade of a steam turbine in which erosion is easily caused by drain, etc.

(Prior art)

In a steam turbine blade, especially in a moist region of a low-pressure part, since the blade surface is eroded by a drain, a stellite of a Co-base alloy has been soldered or attached via welding to the blade surface as its prevention.

However, in long blades such as final stage blade and atomic power low-pressure turbines, the stellite is often eroded due to the high peripheral velocity and the high moistness of the long blades.

Furthermore, along with the improvement of the power generation efficiency, etc., recently, the blade length of the final stage blade has been increased at a low-pressure side of the steam turbine, and the peripheral velocity of the blade tip has also tended to increase. In the low-pressure part of the turbine, the erosion consumption of the front edge of the blade tip has been considerable due

to the high-speed collision of a drain being included in a steam flow during the operation. In particular, /2 since the collision speed of the drain is increased with the increase of the peripheral velocity due to the blade length increase, the usage conditions of the turbine blade have been gradually harsh.

(Problems to be solved by the invention)

As mentioned above, the erosion due to drain, etc., was easily caused in the conventional steam turbine, especially in the final stage blade or a turbine blade at its vicinity.

The present invention considers the above-mentioned points, and its purpose is to provide a method for manufacturing a turbine blade with excellent erosion resistance.

(Constitution of the invention)

(Means to solve the problems)

The surface strengthening method for a turbine blade of the present invention is characterized by the fact that high-energy beams such as laser beams are irradiated to part of the surface of a turbine blade while supplying a hardening material; the above-mentioned hardening material is melted and fused with a blade matrix on the blade surface, so that a surface-hardened layer is formed.

Also, as the hardening material, a Ni-Cr-Fe alloy containing 15-60 wt% high-hardness particles such as metal carbides, metal nitrides, metal oxides, and intermetallic compounds is appropriately used.

On the other hand, in order to obtain a good adhesion with the blade matrix of the turbine blade, to have no large negative influence on the blade matrix, and to simultaneously melt the hardening material and the blade matrix, a heat source with very high concentration is preferably used.

As an energy source that meets such a demand, there are high-energy beams such as laser beams and electron beams. In these high-energy beams, the adjustment of a beam flux and a focal distance is easy, and the energy can be concentrated on an optional point. Furthermore, a surface hardening layer can be formed in an optional area by scanning the beams.

As the high-hardness particles, metal carbides such as TiC, VC, WC, NbC, Cr_2C_3, SiC, and TaC, metal nitrides such as BN, TiN, and Cr_2N, intermetallic compounds such as TiB_2, FeB_2, and NiTi, or oxides such as TiO_2, SiO_2, ZrO_2, Cr_2O_3, Al_2O_3, and Y_2O_3 are mentioned.

Here, although each high-hardness particle itself is very hard and excellent in the erosion resistance, melting

in the blade matrix is difficult, even if a surface layer is formed by the particle element, and the adhesion is deficient.

Accordingly, in the present invention, as a medium that combined each particle and is also fused with the blade matrix, a Ni-Cr-Fe alloy is used. Since this alloy includes Cr, the corrosion resistance is excellent even in a corrosive environment such as low-pressure part of a steam turbine. Also, the ductility and the toughness are sufficient due to Ni and Fe, and even if part of the turbine blade is formed, the reliability as the blade can be sufficiently held. Also, an alloy suitable for the mixture ratio of Ni-Cr-Fe or the chemical composition of the blade matrix can be appropriately selected and used.

If the content of the high-hardness particles in the hardening material is less than 15 wt%, hardening of high-hardness particles cannot be obtained, and if the content is more than 60 wt%, the surface hardening layer formed becomes brittle. Thus, the content of the high-hardness particles is set to a range of 15-60 wt%.

In forming the surface hardening layer, as a method for supplying the above-mentioned hardening material to high-energy beams, a method that sequentially and continuously supplies a powder or rod-shaped solid of the

hardening material to the beam tip, melts the hardening material, melts the blade matrix surface layer, and fuses the hardening material and the blade matrix is suitable, so that a large adhesion can be obtained.

In this method, the thickness of the surface hardening layer can be adjusted to an optional thickness by adjusting the amount of hardening material being supplied. Furthermore, after the surface hardening layer is formed once, the thickness of the surface hardening layer can also be adjusted by repeating the above-mentioned method from the top.

(Operation)

As mentioned above, according to the present invention, the surface hardening layer with a high hardness can be formed in part of a turbine blade, so that the erosion resistance is markedly improved. Also, since the surface hardening layer and the blade matrix are simultaneously melted and fused, the adhesion is considerably high, and the reliability of the blade is /3 considerably improved along with the high erosion resistance.

(Application examples)

Next, application examples of the present invention are explained.

Hardening material powders containing each high-hardness particle shown in the following table were continuously supplied to a blade made of 12Cr steel, and surface hardening layers with a thickness of about 2 mm were formed by laser beams. The irradiation conditions of the laser beams were an output of 3 kW, a moving speed of 0.3 m/min, and an amount of powder supply of 500 g/min.

Table

試験材 No	高硬度粒子	含有量 (%)	表面硬度 (HV)
11	TiC	15	900
12	〃	30	1030
13	〃	60	1170
22	WC	60	1110
32	TiN	60	1560
42	BN	60	1210
52	TiB_2	60	1190
62	Cr_2O_3	60	1550
比較材	ステライト	—	470

1. Testing material
2. High-hardness particles
3. Content (%)
4. Surface hardness (HV)
5. Comparative material
6. Stellite

The Ni-Cr-Fe alloy in the above-mentioned application examples is 12% Cr-1% Ni-balance Fe close to the chemical

composition of the blade matrix, and the hardening materials are formed by changing the content of the powder of this alloy and the high-hardness particles shown in the above table in a range of 15-60 wt%.

The hardness of the surface hardening layer obtained, as seen from the above table, is a high hardness of twice or more, compared with the stellite of the conventional material, and as shown in the figure, the amount of erosion being reduced is reduced to about 1/2 or less of the stellite. Also, the amount of erosion being reduced on the ordinate of the figure is shown by the ratio when the stellite of the conventional material is assumed as 1.

In the above-mentioned application examples, a representative 12Cr steel was used in the blade material, however needless to say, the above-mentioned method can also be applied to blade materials such as 17-4PH steel and titanium alloy being used as blade materials.

Also, as the method for supplying the hardening material, a similar effect can be obtained by a method that attaches the hardening material to the blade surface in advance by thermal spray, etc., melts it by high-energy beams, and fuses it with the blade matrix instead of the above-mentioned method for continuously supplying a power or rod-shaped hardening material.

Also, the present invention is effective for the prevention of an erosion due to oxidation scales being generated in the turbine blade of a high-pressure part and an intermediate-pressure part of a steam turbine or an erosion in solid particles such as sands and dust in gas turbine, etc., as well as the prevention of the above-mentioned drain erosion of a low-pressure part of a steam turbine.

(Effects of the invention)

As explained above, according to the present invention, the surface hardening layer with a high hardness can be easily formed in part of a turbine, so that the erosion resistance can be markedly improved.

Furthermore, in the present invention, since the surface hardening layer and the blade matrix are simultaneously melted and fused, the adhesion is considerably high, and the reliability of the blade can be markedly improved along with the high corrosion resistance.

4. Brief description of the figure

Figure 1 is a graph showing the erosion test results of a turbine blade to which a surface strengthening treatment is applied by the present invention.

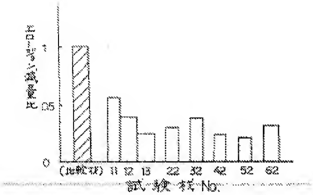

Figure 1:

1. Ratio of the amount of erosion reduced

2. Comparative material

3. Testing material No.